

In the claims

1- 43 (cancelled)

44. (currently amended) A [metal-matrix] composite material for a product having a specified shape and size comprising a [base material] composite matrix reinforced by an additive which has a melting point of at least 300° C greater than that of the [base material] composite matrix:

the additive comprising a plurality of solid elements substantially uniformly and stably distributed in the composite matrix for forming the product;

the composite matrix contacting and bonding together the plurality of the solid elements at a plurality of interfacial contacting and bonding regions inside the product;

each of the plurality of the interfacial contacting and bonding regions between the composite matrix and a respective solid element being metallurgically graded thereby generating a non-abrupt but chemically graded composition profile normally of the respective interfacial contacting and bonding region to minimize stress and strain gradients there across; and

each interfacial contacting and bonding region being continuously uniform, 100% dense, void free under 1000 times magnification and efficiently graded in chemical composition profile to withstand without failure a temperature of at least close to the melting point of the composite matrix.

45. (currently amended) The composite as in claim 44 in which the [base material is a metal base material] composite matrix is a metal matrix which is reinforced by a strengthening additive to enhance said [base material] composite matrix in at least in more than two properties selected from the properties of mechanical strength, thermal stability and electrical properties.

46. (currently amended) The composite material as in claim 44 in which the [metal base] composite matrix is selected from the group consisting of aluminum, magnesium, titanium, iron, nickel, copper, [and] gold and mixtures thereof.

47. (currently amended) The composite material as in claim 44 in which the additive is selected from the group consisting of ceramic, intermetallic and refractory material.

48. (currently amended) The composite material as in claim 44 [in] which [the additive] has an improved creep resistance at temperatures exceeding a melting point [at least 400°C greater than that] of the [base material] composite matrix without the additive.

49. (currently amended) The composite material as in claim 44 [in] which [the additive] has a mechanical strength [at least over 50% more] significantly greater than that of the [base material] composite matrix without the additive.

50. (currently amended) The composite material as in claim [1 in] 44, which [the additive] has a thermal conductivity at least 50% more than that of the [base material] composite matrix without the additive.

51. (currently amended) The composite material as in claim [1 in] 44, which [the additive] has an electrical conductivity at least 50% more than that of the [base material] composite matrix without the additive.

52. (New) The composite material as in claim 44 which has both electrical and thermal conductivities at least 50% more than those of the composite matrix without the additive.

53. (New) A composite material as in claim 44 in which the solid elements are reinforcing elements which cause the composite material to have controlled anisotropic properties in at least one of the following: mechanical property, thermal property, and electrical property.

54. (New) A composite material as in claim 44 for use in semi-conductor manufacturing to achieve at least one of the following: improved device miniaturization and reliability, conductive line width and height, chip planarity and coplanarity, wafer mounting, high density on-chip off-chip interconnect, semiconductor packaging, and chip to board integration.

55. (New) A composite material as in claim 44 in which normally the composite matrix interacts with the solid elements to chemically form brittle intermetallic compounds; has high thermal resistance limiting heat spreading, has high electrical resistance, and has low mechanical strength particularly as to creep, fatigue, or shear, thereby making bonded metallic lead layers or lead wires, circuit board, or even entire electronic system non-heat resistant, short-lived, and unreliable, especially at high temperatures, and

the uniformly distributed, plurality of the solid elements are bonded to the composite matrix to overcome at least one of the above chemical, thermal, electrical, and mechanical problems; to prevent chemical and mechanical decoupling of the solid elements from the composite matrix thereby degrading the quality of the resultant composite material; and to avoid cracking at the solid elements and composite matrix bonding interfaces.

56. (New) A composite material as in claim 44 for use in electronic industry to alleviate a difficulty selected from the group consisting of device miniaturization and reliability; chip planarity and coplanarity wafer warpage, mounting and connecting, semiconductor packaging including very high density on-chip and off chip interconnection; connecting new wafers, chips, devices; and making electronic systems smaller, thinner, lighter, faster, more reliable, and cost effective.

57. (New) A composite material as in claim 44 in which the solid elements comprise fully solid or hollow particles of a type selected from the group consisting of rods, sheets, weaves, special tiny structures, and combinations thereof for use in forming the product having connected components with varying orientations and vastly differing cross-sectional thicknesses of less than 25 to 125 microns.

the plurality of the solid elements being substantially uniformly and stably distributed in the finished composite material product which is a low-cost, net-formed product in exact shape or net shape and capable of being immediately used without additional processing.

58. (New) A composite material as in claim 44 in which the solid composite matrix is a metallic bonding material selected from the group consisting of soldering alloy, brazing alloy, and welding alloy; and

the solid elements are solid reinforcing elements to reinforce at least one composite material property selected from the group consisting of chemical property mechanical property, thermal property and electrical property; and

the improved uniformity of the distribution of the solid elements in the composite matrix ensure uniform spacing between the solid reinforcing elements in the composite matrix to thereby enhance and heat transfer among the solid reinforcing elements through the intervening composite matrix, even with different product components of different orientations and vastly differing sectional thicknesses, whereby the finished product has improved selected chemical, mechanical, thermal, and electrical characteristics.

59. (New) A composite material as in claim 44 in which the solid elements are solid reinforcing elements of a material selected from the group consisting of ceramic, intermetallic, metal, glass, or a mixture thereof, and having at least one of the improved properties selected from the group consisting of mechanical strength, rigidity, and heat-resistance; and

the solid reinforcing elements are neither overcrowded nor under populated anywhere in the composite material to prevent premature composite matrix failures by hot tear, fracture, or creep and to make the entire composite material reinforced particularly as to at least one of the following: strength, rigidity and heat-resistance, creep, fatigue,

and tensile and shear properties at temperatures near the melting point of the composite matrix.

60. (New) composite material as in claim 44 in which the solid elements are of a material selected from the group consisting of Al_2O_3 , MgO, SiC, SiO_2 , TiO_2 , SiB_6 , and ZrO_2 natural rocks, and minerals; and the composite matrix is selected from the group consisting of Au, W, Ta, Pb, Mo, Bi, Ag, Fe, Ni, Cu, Al, Mg, Co, Sn, Al, Ga, Zn, Cr, Cd, Pt, Pd, Os, and Re.

61. (New) A composite material as in claim 44 in which the composite matrix is a metallic alloy having at least two component metals which differ in densities by less than 10 to 20% from each other.

62. (New) A composite material as in claim 44 in which the solid elements are of a ceramic material; and including a ceramic metallizing layer less than 3 microns thick thereon, and the solid elements are continuously bonded to the composite matrix for obtaining strong, voidless at 1000 times magnification, 100% dense bonds between the ceramic material of the solid elements and the composite matrix thereby improving ceramic wetting, processing reliability, and compound product qualities.

63. (New) A composite material as in claim 44 in which the solid elements are of a ceramic material; and the bonding between the ceramic solid elements and the composite matrix can withstand without failure a temperature of up to $950^{\circ}C$.

64. (New) A composite material as in claim 44 for use in modern electronics and in which the solid elements are solid reinforcing elements; and the reproducibly uniform distribution of the solid reinforcing elements in the composite matrix provides at least one of the following benefits: reducing coplanarity problems (no leads); minimizing placement problems (self-centering), reducing paste printing problems (bridging); minimizing handling issues (no damaged leads); achieving lower profile (smaller size), achieving better electrical and thermal performance; enhancing better package and assembly yield; allowing higher interconnect density permitting cavity-up or down options; providing multilayer interconnect options; shortening wire bonds; facilitating multichip modules; and achieving faster design to production cycle time.

65. (New) A composite material as in claim 44 in which the solid elements have an average specified solid density and the composite matrix is a liquid having a substantially constant liquid density; and the average specified solid density is within a given percentage of the substantially constant liquid density; the given percentage being selected from the group consisting of 2%, 5%, and 10%.

66. (New) A liquid composite material as in claim 44 for use in an industry selected

from the group consisting of automotive, electronics, aerospace, health, education, communication, defense and entertainment.

67. (New) A composite material as in claim 44 in which the product is selected from the group consisting of fast computers, satellite communication systems, deep well drilling equipment, jet engines, gas turbine, cellular phones, instruments, entertainment devices, educational systems and transportation.

68. (New) A composite material as in claim 44 in which the metallurgically graded, bonding interfacial regions minimizes product failure modes selected from the group consisting of high temperature, thermal degradation, electrical degradation, creep, fatigue, voiding, solder balling and spreading, insufficient solder, misregistration, opens from poor solder wetting, and warpage from thermal or mechanical stressing.

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